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The Patent Office

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I also certify that the application is now proceeding in the name as identified herein.

I also certify that the attached copy of the request for grant of a Patent (Form 1/77) bears an amendment, effected by this office, following a request by the applicant and agreed to by the Comptroller-General

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GB 0407297.1

By virtue of a direction given under Section 30 of the Patents Act 1977, the application is proceeding in the name of:

ARTEMIS INTELLIGENT POWER LIMITED,
Sanderson Building,
Mayfield Road,
EDINBURGH,
EH9 3JL,
United Kingdom

Incorporated in the United Kingdom,

[ADP No. 06593065001]

Patents Form 1/77

Patents Act 1977
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Request for grant of a patent

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The Patent Office

Cardiff Road
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1. Your reference C06465

31MAR04 E885446-1

2. Patent application number (*The Patent Office will fill in this part*) 0407297.1

APPLICATION FILED 29/3/05

3. Full name, address and postcode of the or of each applicant (*underline all surnames*)
(1) Mr. N. J. Caldwell, Dr. W. H. S. Rampen (2)
(3) Dr. U. P. B. Stein
Artemis Intelligent Power Ltd. Sanderson Bldg. Mayfield Rd
Edinburgh EH9 3JL

SECTION 30 (1977) ACT

Patents ADP number (*if you know it*)

If the applicant is a corporate body, give the country/state of its incorporation

(1) 08732539001
(2) 06627541001 (3) 08840555001

4. Title of the invention

Fluid Working machine with Displacement Control

5. Name of your agent (*if you have one*)

"Address for service" in the United Kingdom to which all correspondence should be sent (*including the postcode*)

Bromhead Johnson
Kingsbourne House
229-231 High Holborn
London
WC1V 7DP
(51/77 14.4.05)

Patents ADP number (*if you know it*)

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (*if you know it*) the or each application number

Country	Priority application number (*if you know it*)	Date of filing (*day / month / year*)

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing (*day / month / year*)

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? (*Answer 'Yes' if:*
a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
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Claim(s)	
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Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. N.J. Caldwell
W.H.S Rampen
4PB. Stein

I/We request the grant of a patent on the basis of this application.

Signature Niall Caldwell

Date 30/03/2004

12. Name and daytime telephone number of person to contact in the United Kingdom Dr. W.H.S Rampen 0131 650 5700

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Fluid Working Machine with displacement control

Inventors: N.J. Caldwell, W.H.S. Rampen, U.P.B. Stein, Artemis Intelligent Power Ltd.

Background

This patent describes a method of altering the time-averaged flow of a fluid working machine operating in all four quadrants of motion. The method is applicable to any machine with working chambers, which alternately expand and contract, whether by pistons and cylinders, vanes, lobes or gears and where the primary method of commutating fluid to the working chambers is by a rotating port plate, synchronised to the phase of the chamber expansion and contraction cycle, which alternately connects high and then low pressure fluid manifolds to each working chamber.

Description of Invention

Referring to Figure 1: by placing an actively controllable on-off valve 1, in series with the commutator plate 2, into the fluid passage 3 between the commutator plate and the working chamber 4, the flow into the working chamber can be controlled. When the machine is working with the shaft 5 rotating, and the on-off valve closed prior to the opening of the fluid inlet port 2a on the commutator, then the expansion stroke of the working chamber will occur in a partial vacuum. The return stroke will collapse the bubble, caused by cavitation or air-release, by the time the chamber returns to its minimum volume. In doing so the working volume will have exchanged no work with the fluid system while absorbing very little parasitic work . It would also be possible to avoid cavitation and air-release by fitting a non-return valve 4a between the working chamber and the low-pressure line. Operating the working chamber with the on-off valve closed will result in an idle cycle.

When the valve 1 is left in the open position the working chamber functions, as normal, to produce a working cycle. The time averaged flow is varied by deciding on a chamber-by-chamber basis whether to effect idle or working cycles. The decisions are taken as each successive chamber nears the minimum volume condition, irrespective of whether the machine is working as a pump or a motor. An electronic controller 6 senses the phase of the working chamber cycle through the use of a once per revolution shaft sensor 7, an encoder, a resolver or some similar means. At times coinciding with the minimum working chamber volume the controller can either leave the on-off valve in its de-energised open state or pull it closed through electromagnetic means. In addition to the timing function, the controller reads the system demand, either through an analogue or digital input line or a bus 8, and decides whether the working chamber reaching the minimum volume condition should be left working or idled by closing the valve 1. It is envisaged that the on-off valve would default to the open position and be pulsed to close,

but it is possible to see that the opposite operating mode, i.e. default closed, pulse to open would also have application where a power-off freewheel characteristic was required.

The controller decisions can also be made entirely on the basis of shaft speed in order to limit the rate of increase of shaft power. In such a mode of operation the electronic controller would require no external demand signal and would make the sequential on-off valve actuation decisions on the basis of a pre-programmed flow versus speed function.

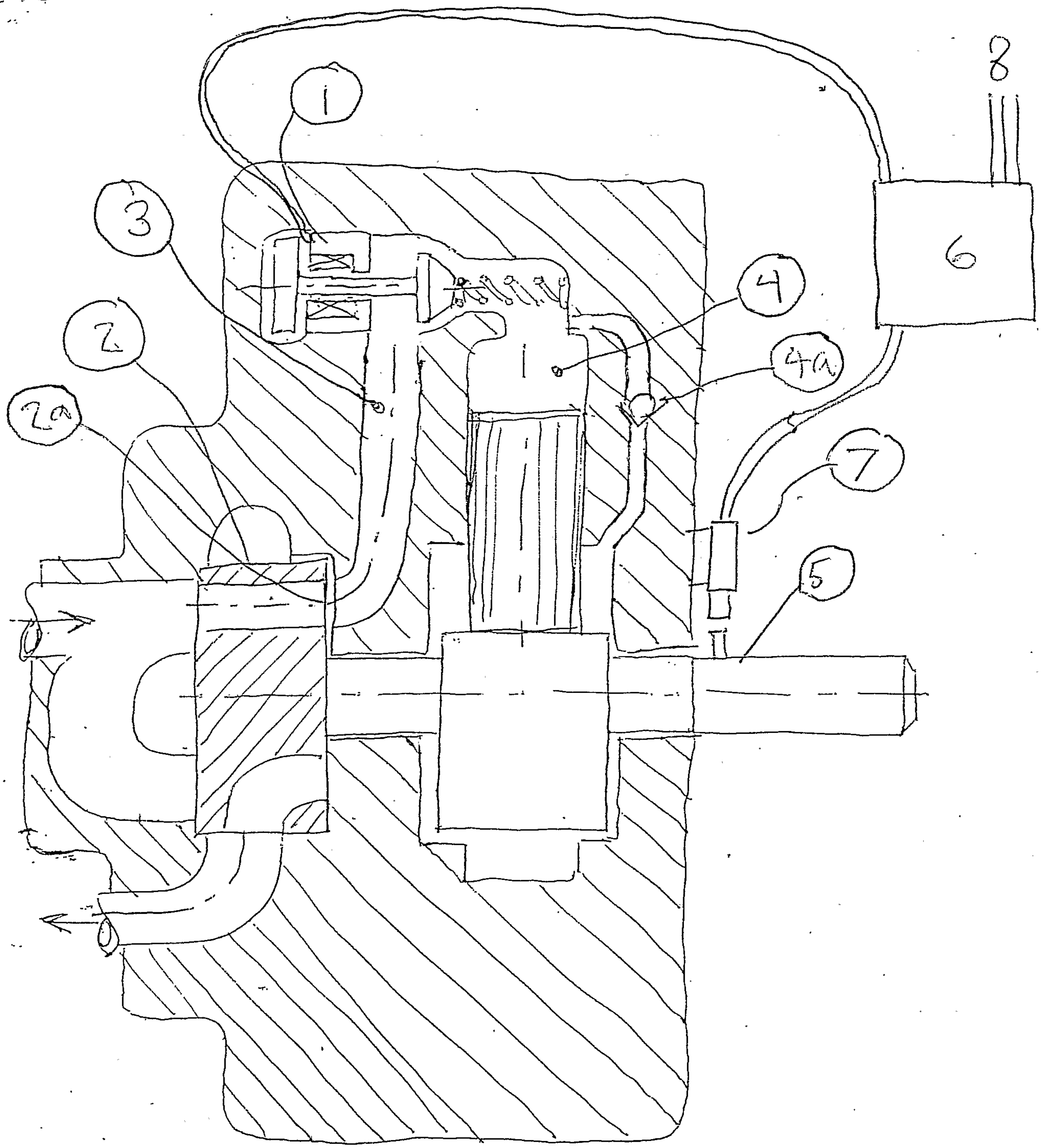
In the instance of a vehicle propulsion circuit, where external demand signals are read by the electronic controller, the decision sequence can be determined in order to limit individual wheel slip, to create a skid steering effect or to create graded changes in torque and thus controlled vehicle accelerations.

What is claimed is:

1. A fluid working machine with variable volume working chambers each of which is connected to a fluid commutating means which alternately connects the working chamber to either of two fluid manifolds, where an electronically controlled valve member is inserted into the flow path between each chamber and the commutating means and where the sealing valve is commanded by a controller and where the controller receives input of the phase angle of the shaft of the machine or at least one electronic pulse per revolution which informs the controller that the shaft is passing a known phase angle
2. As claim 1. But where the controller chooses whether to actuate the sealing valve, each time the working chamber volume is approaching the minimum volume condition, such that the sealing valve is closed close to the time the working chamber begins its expansion stroke, if it is desired to isolate the working chamber from the commutating means.
3. As claims 1 and 2 but where the controller sums the previous flow demand to create a total displacement demand and compares it with the actual displacement through the machine over the same time period to determine the displacement error and where, the controller chooses either to isolate the working chamber or to leave it active in order to minimise the ongoing accumulated displacement error.
4. As claims 1 and 2 but where the controller reads a demand from an external signal line and decides whether to isolate working chambers, as they reach the minimum volume condition, in order to regulate either speed or torque
5. As claims 1 and 2 but where the controller makes the decisions to isolate working chambers on the basis of sensed shaft speed so that the fraction of working cylinders to idle cylinders decreases, according to a pre-determined function, as the machine speeds up, in order to either maintain a constant level of throughput flow or one which rises less quickly than the shaft speed increase would indicate.
6. As claim 1 but in the case where the fluid machine is working as a motor, where the controller can choose to close the sealing valve at a time such that the sealing valve closes some fraction of the way into the expansion stroke of the chamber, such that the chamber is connected to the commutator for a fraction of the full working stroke,

such that the volume of fluid working to drive the load in that expansion stroke is a fraction of the full geometric displacement of the chamber.

7. As claim 1 but in the case where the fluid machine is working as a pump, where the controller can choose to close the sealing valve at a time such that the sealing valve closes some fraction of the way into the expansion stroke of the chamber, such that the chamber is connected to the commutator for a fraction of the full working stroke, such that part of the expansion stroke consists of pulling a partial vacuum in the chamber, such that when the next contraction stroke begins, the chamber does not act as a pump immediately but at some fraction of the way into the contraction stroke, such that the contraction stroke displaces only a fraction of the full geometric displacement of the chamber into the commutating means.
8. As claim 1 but where the controller can reduce the loss of energy in the compressed fluid by closing the sealing valve just before the chamber reaches its maximum volume condition so that the remaining expansion can de-pressurise the fluid contained within the chamber before the commutating valve port is opened to the low-pressure manifold.



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